Changing choices: a neurocognitive examination of decision-making during adolescence

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CHAPTER 5

Social information influences trust behaviour in adolescents

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ABSTRACT

Trust plays an integral role in daily interactions within an individual's social environment. Using a trust game paradigm, this study investigated the modulating influence of social information about interaction partners on trust behaviour in adolescents aged 12-18. Results showed that on initial trials participants were most likely to share with a 'good' partner and rate this partner as most trustworthy. Despite a decrease in this trust during the task, participants continued to trust and view the 'good' partner as more trustworthy than 'bad' and 'neutral' partners throughout the game, though all partners showed similar levels of trustworthy behaviour. Mid and late adolescents showed a larger decrease in trust of the 'good' partner than early adolescents. This suggests an improved ability to overcome prior social information and adapt trust behaviour accordingly.

INTRODUCTION

Trust plays an integral role in smooth and efficient social interactions by encouraging cooperative behaviour (King-Casas, et al., 2005). These interactions occur within an individual's social environment, with interaction partners they have prior social knowledge of or have previously interacted with. Studies in adults have shown that this social context influences trust. For example, adults are more likely to share rewards with others if they know that the other has previously shown trustworthy behaviour

(Bracht & Feltovich, 2009). Up till now studies of the development of trust during adolescence have focused on interactions with anonymous partners. To increase the understanding of the development of trust during adolescence, this study examines the influence of social information about interaction partners on the development of trust behaviour.

Previous research has shown that trust is present from an early age and continues to develop during adolescence (Sutter & Kocher, 2007; Van den Bos, Westenberg, Van Dijk, & Crone, 2010). This development of trust is thought to be related to an increase in the capacity to view an interaction from the perspective of the interaction partner, thus improving the ability to anticipate his or her intentions, known as perspective-taking (Frith & Singer, 2008; McCabe, Smith, & LePore, 2000; Sharp, Ha, & Fonagy, 2011). Improved perspective-taking abilities increase the adolescent's consideration of the complex thoughts, beliefs and intentions of others when making decisions (Choudhury, Blakemore, & Charman, 2006). Furthermore, the ability to take the perspective of another has been found to motivate prosocial behaviour (Eisenberg, Cumberland, Guthrie, Murphy, & Shepard, 2005; Eisenberg, Zhou, & Koller, 2001). In children, perspective-taking abilities are positively related to trustworthy behaviour towards a partner, as well as the rejection of unfair offers made by a partner when playing an interactive game (Castelli, Massaro, Sanfey, & Marchetti, 2010; Sally & Hill, 2006).

In recent years application of game-theoretical approaches has enabled the development of behavioural paradigms to study trust behaviour (Camerer, 2003; Glaeser, Laibson, Scheinkman, & Soutter, 2000). These require participants to engage in cooperative social interactions reflecting realistic 'real-life' settings (Frith & Singer, 2008). An oft-used paradigm is the trust game, during which a player allocates a hypothetical amount of money between themselves and a partner within an interactive setting (Berg, Dickhaut, & McCabe, 1995). In a one-shot trust game the game starts with player 1, known as the investor, receiving a certain amount of hypothetical money (or tokens). The investor is then given the option to keep the money or to invest a proportion in player 2, the trustee. If the investor chooses not to invest the game ends and the trustee receives nothing. But, the investor can also decide to invest

in the trustee, thereby displaying trust. In that case the invested amount is tripled in value and the trustee receives three times the invested amount. The trustee is then faced with the same decision: keep the money, or reciprocate and repay the investor's trust by sharing the money. In an iterated version of the trust game, the investor and trustee play multiple rounds together, thereby enabling examination of the effect of reputation building during the game (King-Casas, et al., 2005). Research in adults has shown that in most cases the investor will make a considerable investment offer, and this will be reciprocated by a reasonable return offer from the trustee (Johnson & Mislin, 2009).

Harbaugh, Krause, Liday and Vesterlund (2003) conducted one of the first developmental studies using the trust game and examined a group of participants aged 8-18 years. Half the participants were allocated the role of investor and asked to allocate 4 tokens between themselves and the trustee. The results failed to show an increase in trust or reciprocity in the sample. However, the participants did invest the tokens they were given at a rate lower than that often observed in adult studies. The authors hypothesised that observed behaviour was a result of the method used and not of a lack of age differences (see Harbaugh, et al., 2003 for more information). Later studies seem to confirm this. For example, Sutter and Kocher (2007) compared six age groups, the youngest aged 8 years and the oldest comprising retired adults. Their results showed that trust increased almost linearly from childhood, stabilising in late adolescence, while reciprocity continued to develop into adulthood. Other subsequent studies have also demonstrated continued improvements in trust and reciprocity from early to late adolescence (van den Bos, van Dijk, Westenberg, Rombouts, & Crone, 2011; van den Bos, et al., 2010).

Studies in adults have shown that prior social knowledge of interaction partners influences trust game behaviour. A study by Goto (1996) showed that the relationship between the investor and trustee influences trust: the better you know someone the more likely you are to trust them, especially in situations with high potential losses. Others have demonstrated that initial impressions also influence trust behaviour. For example, people invest more in partners whose face they previously rated as trustworthy (van't Wout & Sanfey, 2008). Recent work by Fett and colleagues (In

press) has shown that participants made significantly higher investments after being informed that they were interacting with a trustworthy partner. Delgado, Frank & Phelps (2005) found that information about interaction partners influenced trust in two ways: firstly, prior social information about interaction partners affected the initial trust individuals placed in these partners: participants were more likely to trust a trustee who they had received positive information about then a trustee they had received negative information about. Secondly, they showed that feedback about the interaction partner during the game failed to alleviate these differences in trust, despite both partners showing equal amounts of reciprocation during the game.

It seems that two types of social information can be distinguished which influence trust behaviour: prior information about interaction partners and feedback information based on behaviour during the trust game. Neither of these has previously been examined developmentally during adolescence. However, adolescence is a particularly interesting developmental period during which to study these effects. During adolescence, emotional responsiveness to social stimuli and socially related events increases, and social information becomes highly salient within decision-making contexts (Nelson, Leibenluft, McClure, & Pine, 2005). At the same time, due to the relative immaturity of the cognitive control system, adolescents are often unable to self-regulate their behaviour when attention-grabbing socially and emotionally evocative events occur (Monk, et al., 2003). As a result, social and emotional information strongly influences adolescent behaviour (Silk, et al., 2009). Over the course of adolescence the integration of the cognitive and emotional networks increases, leading to enhanced cognitive control and goal-directed behaviour, as well as a decline in the influence of social and emotional stimuli (Hare & Casey, 2005; Nelson, et al., 2005; Somerville & Casey, 2010). However, as the aforementioned study by Delgado and colleagues (2005) shows, using cognitive control to adjust behaviour in social contexts still poses difficulties for adults, for example when faced with incongruent feedback about an interaction partner's behaviour.

The continued integration of cognitive and emotional networks during adolescence, combined with the increased salience of social and emotional stimuli during this period, makes it likely that adolescent trust behaviour will be particularly

affected by social knowledge of interaction partners. Therefore, the present study was designed to examine the influence of social knowledge of interaction partners on trust behaviour during adolescence. A group of 852 adolescents aged 12-18 years played an iterated version of the trust game against three fictitious partners who they received information about prior to playing the game. One partner was trustworthy (the 'good' partner), one was not trustworthy (the 'bad' partner) and the information about the third partner was not related to their trustworthiness ('neutral' partner). In line with previous research we expected overall trust to increase with age (Sutter & Kocher, 2007; Van den Bos, et al., 2010). However, we expected this effect to differ between the interaction partners. We hypothesised that participants would adjust their initial trust behaviour according to the information they received about their interaction partners. More specifically, we expected the highest levels of trust in the 'good' partner and the lowest levels in the 'bad' partner. Furthermore, we hypothesised that the information received prior to the task would have the greatest effect in the youngest age group, as they are most sensitive to social and affective stimuli (Silk, et al., 2009). Additionally, we assumed that feedback received during the task would also have the least influence on subsequent trust behaviour in the youngest adolescents in our sample, as they are less able to ignore previous salient information about their interaction partners and regulate their behaviour to attend to the new and possibly incongruent information they receive about these partners during the task.

METHOD

PARTICIPANTS

Participants were recruited from secondary schools in the Netherlands within a larger project examining the development of decision-making abilities during adolescence. All participants were enrolled in mainstream education and had not previously been diagnosed with a neurological, psychological or learning disorder. A total of 7 participants were excluded from the analyses due to incomplete data. The remaining 845 participants were divided into three age groups: early adolescence (12-13 year-olds), mid adolescence (14-15 year-olds) and late adolescence (16-18 year

olds). Chi-square tests showed that the proportion of males and females did not differ significantly within the age groups. Demographic characteristics of the participants are presented in Table 1.

Table 1 - *Demographic characteristics of participants*

	AGE *M (SD)*	SEX (% FEMALE)	*N*
EARLY ADOLESCENTS	13.22 (.34)	56.1%	243
MID ADOLESCENTS	15.22 (.40)	49.6%	381
LATE ADOLESCENTS	17.53 (.75)	50.5%	221
TOTAL	15.32 (.50)	51.6%	845

MATERIALS AND PROCEDURE

Data collection took place in participating schools in the school's computer lab under supervision of the classroom teacher and two trained psychologists. Parents were notified in writing about the project prior to testing. Both parents and participants were asked to sign and return the enclosed consent form if they wished to participate. Certain schools elected to modify this procedure and only asked parents to inform their child's teacher if they did not wish for their child to participate. No parents objected to their child's participation.

During the test session all participants were seated at a pre-assigned computer. They were instructed that they would all be playing an online game against three different hypothetical partners. Participants were told that in each round of the game they would play the role of player 1, the investor and receive €2. They could either keep the entire amount, or choose to share and send it to player 2, the trustee[1]. If they chose to invest in the trustee, the amount was tripled to €6. The trustee could subsequently either defect and keep all the money, or cooperate and share it with the investor, with both the investor and trustee receiving €3.

Following the task instructions, participants played three practice rounds in which they received feedback about their answers to ensure they had understood the

1 While we use the terms 'investor' and 'trustee' here, our protocol used the neutral terms 'player 1' and 'player 2.'

game. In a design similar to that used by Delgado and colleagues (2005), the practice rounds were followed by a priming phase during which the participants read a short news story about each of the three partners. All partners were described as 16 or 17 year old males to prevent confounding of results due to differences in age or sex between the partners. A photograph of a neutral face accompanied each story (taken from Minear & Park, 2004). The faces were all rated as equally trustworthy by a group of adolescents during a pretesting phase.

Participants were told that the stories they read would give them additional information about their partners and that their partners may or may not play the game according to the described characteristics. In reality, all three partners were programmed to have the same reinforcement rate of 70% cooperate and 30% defect. For two of the partners, the 'good' and 'bad', the information in the stories related to their trustworthiness. The 'good' partner had recently prevented an old lady from being mugged by scaring off the attackers. The 'bad' partner had been caught by police attempting to break into a car with friends. The third 'neutral' partner had won a flight on a classic plane at an air show but luckily missed the flight because he was late, as the plane crashed during the flight. After reading the stories, participants were asked to rate the trustworthiness of each of the partners on a 7-point likert scale. Three versions of the task were created to counterbalance the faces with the positive, negative and neutral stories.

The priming phase was followed by the trust game, which consisted of 30 intermixed trials, 10 played against each partner. During each trial, the participants were presented with the face and name of their partner for that trial and asked if they wished to share or keep their €2. After entering their response, they were shown a second screen with one of the three possible outcomes of the trial (the participant chose to keep, the partner reciprocated and chose to share or the partner defected and chose to keep), as well as the amount they had earned during that trial.

After completing the trust game, participants were again asked to rate the trustworthiness of the three partners as well as complete a short questionnaire. They were told that a number of randomly selected rounds would be used to determine their payout at the end of the game. In reality, participants in the youngest age group

received €5 for their participation and those in the two older groups received €7.50. The VU University Amsterdam institutional ethical review board approved all procedures.

ANALYSES

The effectiveness of the manipulation was checked using a 3 x 3 repeated measures ANOVA, with within-subjects factor Condition ('good', 'neutral' and 'bad' partner) and between-subjects factor Age (early, mid, late adolescence) to analyse reported levels of trustworthiness after reading the stories about each of the interaction partners. To examine the initial effect of the manipulation on trust behaviour, another 3 x 3 repeated measures ANOVA with within-subjects factor Condition and between-subjects factor Age, was used to examine the number of share decisions made by participants on early trials. This was defined as the first five trials per condition.

Changes in both trust and trustworthiness ratings were examined by computing change scores per condition. The trustworthiness change score was defined as the change in trustworthiness rating between the pre trust game and post trust game measurement. The trust change score was defined as the change in number of share decisions made by the participant on early versus late trials, with late trials comprising the final five trials per condition. Change in trustworthiness and trust behaviour during the trust game were examined per condition using a 2 x 3 repeated measures ANOVA with within-subjects factor Time (respectively pre and post trustworthiness and early versus late share trials) and between-subjects factor Age.

As similar reinforcement rates were programmed in each of the three conditions, a 3 x 3 repeated measures ANOVA, with within-subjects factor Condition and between-subjects factor Age, was used to examine both post trust game trustworthiness ratings as well as the number of share decisions made by participants on late trails.

All effects are reported as significant at $p < .05$. In analyses where the assumption of sphericity was violated, degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity. Significant main effects were further examined using post hoc Bonferroni-adjusted pairwise comparisons where appropriate. Significant interaction effects were followed up using one-way ANOVAs. All analyses were

performed using PASW Statistics 17.0 for Mac.

RESULTS

MANIPULATION CHECK

Trustworthiness ratings following the manipulation, as measured by the self-report questionnaire, indicated that the manipulation affected the way participants viewed their interaction partners (Table 2). Trustworthiness differed significantly per condition (Greenhouse-Geisser F (1.87, 1575.88) = 780.95, $p < .001$, partial $\eta^2 = .48$), with post hoc Bonferroni analyses showing that all conditions differed significantly in trustworthiness ratings, with the 'good' partner receiving the highest rating, followed by the 'neutral' partner. The lowest level of trustworthiness was reported for the 'bad' partner. There was also a significant main effect of age (F (2, 842) = 3.55, $p = .029$, partial $\eta^2 = .01$), with post hoc Bonferroni analyses showing that late adolescents reported higher levels of trust in their partners than early adolescents. The Condition x Age interaction was not significant.

THE INFLUENCE OF PRIOR INFORMATION ON INITIAL TRUST BEHAVIOUR

Analyses of trust behaviour on early trials of the trust game showed a behavioural effect of the manipulation (Table 2). In line with the hypothesis that prior social information would affect behaviour, a main effect of condition was found (Greenhouse-Geisser F (1.93, 1638.39) = 268.33, $p < .001$, partial $\eta^2 = .24$). All participants made the highest number of share decisions when playing with the 'good' partner and the lowest number of share decisions when playing with the 'bad' partner. The main effect of age, as well as the Condition x Age interaction, was not significant. Overall, the information participants received about their interaction partners prior to the game influenced decision-making in the early stages of the trust game.

THE EFFECT OF REPUTATION BUILDING: CHANGES IN TRUST AND TRUSTWORTHINESS DURING THE TRUST GAME

Over the course of the trust game, participants received feedback about the decisions made by their partners, thus enabling them to adjust their decisions in light of their

Table 2 - *Effect of prior information: age differences in mean initial trustworthiness ratings and number of early share trials.*

	RATING BEFORE TRUST GAME			EARLY SHARE TRIALS		
	'GOOD' PARTNER *M (SD)*	'NEUTRAL' PARTNER *M (SD)*	'BAD' PARTNER *M (SD)*	'GOOD' PARTNER *M (SD)*	'NEUTRAL' PARTNER *M (SD)*	'BAD' PARTNER *M (SD)*
EARLY ADOLESCENTS	5.16 (1.9)	4.69 (1.44)	2.35 (1.53)	3.23 (1.31)	3.05 (1.26)	1.76 (1.34)
MID ADOLESCENTS	5.50 (1.52)	4.76 (1.27)	2.33 (1.48)	3.37 (1.23)	3.09 (1.30)	1.78 (1.39)
LATE ADOLESCENTS	5.61 (1.64)	4.67 (1.60)	2.49 (1.43)	3.16 (1.32)	3.08 (1.28)	2.10 (1.46)

Table 3 - *Effect of feedback during the task: age differences in mean post trust game trustworthiness ratings and number of late share trials*

	RATING AFTER TRUST GAME			LATE SHARE TRIALS (TRIALS 6-10)		
	'GOOD' PARTNER *M (SD)*	'NEUTRAL' PARTNER *M (SD)*	'BAD' PARTNER *M (SD)*	'GOOD' PARTNER *M (SD)*	'NEUTRAL' PARTNER *M (SD)*	'BAD' PARTNER *M (SD)*
EARLY ADOLESCENTS	4.36 (1.69)	3.62 (1.71)	3.81 (1.80)	2.98 (1.44)	2.93 (1.32)	2.24 (1.56)
MID ADOLESCENTS	4.16 (1.52)	3.90 (1.45)	3.90 (1.67)	2.77 (1.42)	2.89 (1.44)	2.34 (1.53)
LATE ADOLESCENTS	3.94 (1.64)	3.96 (1.65)	3.94 (1.78)	2.56 (1.45)	2.74 (1.52)	2.41 (1.69)

increased knowledge of their partners. As can be seen in Figure 1, this resulted in trustworthiness scores for the 'good' partner significantly decreasing during the trust game (F (1, 838) = 261.84, p <. 001, partial η^2 = .24). A similar decrease was seen in the neutral condition (F (1, 840) = 162.49, p < .001, partial η^2 = .16). In contrast, the trustworthiness rating of the 'bad' partner increased during the trust game (F (1, 839) = 369.65, p < .001, partial η^2 = .31). Changes in the decrease of the trustworthiness rating of the 'good' partner differed per age group, as indicated by a significant Time x Age interaction (F (2, 838) = 9.29, p <. 001, partial η^2 = .02). Early adolescents showed a significantly smaller decrease in their rating than mid and late adolescents. No significant effects of Age or Time x Age interactions were found in changes in the trustworthiness rating of the 'bad' and 'neutral' partners.

Changes in trust behaviour generally mirrored those of trustworthiness ratings. As Figure 2 shows, sharing increased in late trials compared to early trials when playing with the 'negative' partner (F (1, 844) = 68.51, p < .001, partial η^2 = .08). The

number of trials participants chose to share with their partners was lower for late trials compared to early trials when playing with the 'good' (F (1, 845) = 74.95, p < .001, partial η^2 = .08) and 'neutral' partners (F (1, 845) = 16.91, p < .001, partial η^2 = .02). In the condition with the 'good' partner, a main effect of age was also found (F (1, 845) = 74.95, p < .001, partial η^2 = .08), due to early adolescents sharing on fewer trials than late adolescents. Additionally, a significant Time x Age interaction was also found in the 'good' condition (F (2,845) = 3.61, p = .015, partial η^2 = .01), with early adolescents showing a smaller decrease in the number of share trials during the trust game then mid or late adolescents. Thus, in general, participants adapted their behaviour in each of the conditions over the course of the trust game after realising that their partners where not responding in the way they had anticipated. In the case of the 'good' partner, the older age groups adapted their behaviour more than the early adolescent group.

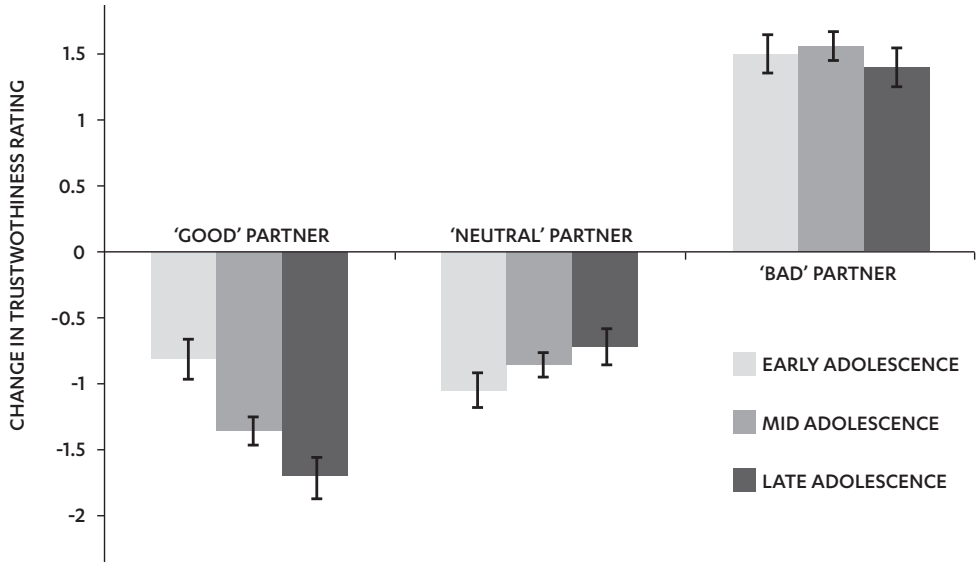

Figure 1 - *Changes in trustworthiness ratings during the trust game per age group.*

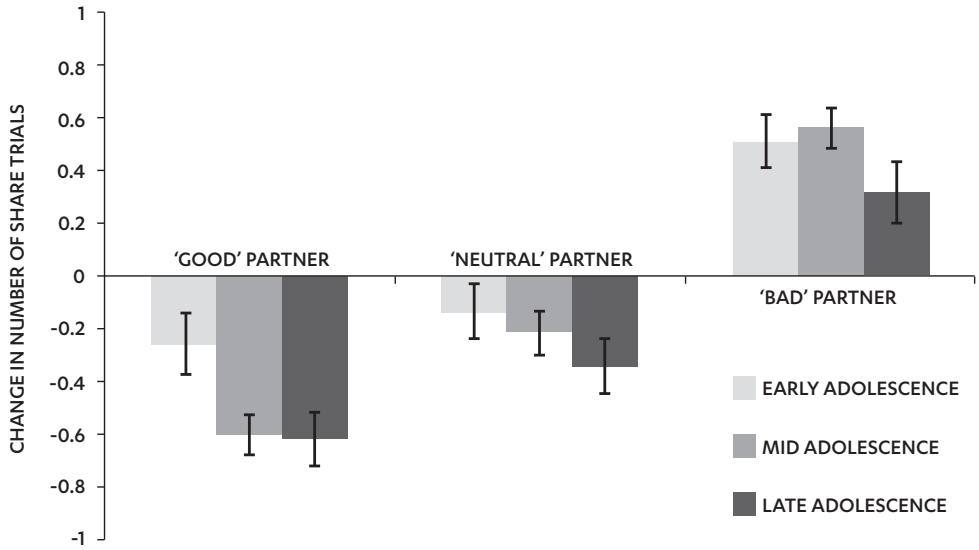

Figure 2 - *Difference between number of early and late share trials per age group.*

TRUST AND TRUSTWORTHINESS AFTER PLAYING THE TRUST GAME

Trustworthiness ratings after completion of the trust game differed per condition (Greenhouse-Geisser F (1.97, 1649.87) = 7.99, $p < .001$, partial $\eta^2 = .01$). Ratings of the 'good' partner were higher than those for the 'neutral' or 'bad' partners (Table 3). A significant Condition x Age interaction (Greenhouse-Geisser F (3.48, 1649.87) = 3.05, $p = .02$, partial $\eta^2 = .01$) showed that these differences between conditions differed per age group. Post hoc one-way ANOVAs per condition showed that early adolescents reported significantly higher levels of trustworthiness for the 'good' partner than late adolescents. No differences between age groups were found for the other conditions.

Behaviour on late trials showed a similar effect (Table 3). There was a main effect of condition, with participants sharing more with the 'good' and 'neutral' partners than the 'bad' partner (Greenhouse-Geisser F (1.97, 1649,87) = 7.99, $p < .01$, partial $\eta^2 = .01$). This behaviour differed between age groups, with post hoc one-way ANOVAs showing that early adolescents shared with the 'good' partner on more trials than late adolescents. A significant Condition x Age interaction was also found, indicating that

the differences between the conditions were not the same for the three age groups (Greenhouse-Geisser F (3.95, 1649,87) = 3.05, p =. 02, partial η^2 = .01). Post hoc one-way ANOVAs per condition showed that on trials with the 'good' partner, early adolescents shared more than late adolescents. Sharing behaviour did not differ between age groups for the other conditions.

DISCUSSION

The primary question of interest in this study was how social information about interaction partners influenced trust behaviour during adolescence. Previous studies have examined the development of trust during adolescence in interactions with anonymous partners (Harbaugh, et al., 2003; Sutter & Kocher, 2007; van den Bos, et al., 2010). The influence of social information on adolescent trust has not previously been addressed. The results of the current study showed that social information altered adolescent trust behaviour. Adolescents initially placed more trust in a partner they had been led to believe was trustworthy than in a partner they believed was not trustworthy or whose trustworthiness they knew nothing about. Furthermore, though participants incorporated the feedback they received about their partners over the course of the task in subsequent decisions, this effect differed across conditions and between age groups. These findings will now be discussed in more detail.

Analysis of the trustworthiness ratings showed that the initial task manipulation was successful: trustworthiness differed between the three conditions before participants played the trust game. These trustworthiness ratings increased with age, with late adolescents reporting higher levels of trust in their partners than early adolescents. In contrast to this finding and to our prior expectations, this did not lead to behavioural differences, as the number of early share trials did not differ between age groups.

The manipulation did result in behavioural differences between conditions on early trials of the trust game. All participants shared most with the 'good' partner and least with the 'bad' partner. These observed differential effects of the manipulation per condition are consistent with previous studies in adults, which have shown that

individuals will modify their level of trust in a partner based on an initial impression, a small amount of prior information or on observations of previous behaviour. For instance, in a study in adults participants were more likely to reject a fair offer in an ultimatum game if their interaction partner had been described as selfish and more likely to accept an unfair offer if their partner had been described as generous (Marchetti, Castelli, Harle, & Sanfey, 2011). Other research has shown that adult participants are more likely to trust a partner who showed trustworthy behaviour during a previous trust game with another person (Bracht & Feltovich, 2009), or who they implicitly believe to be trustworthy based on their facial features (van't Wout & Sanfey, 2008). A recent study by Hillebrandt, Sebastian and Blakemore (2011) showed that a short and superficial interaction within an online game was sufficient to modify levels of trust.

The effect of feedback about the partner's behaviour during the trust game was also examined. All age groups adapted both their trustworthiness ratings and sharing behaviour in response to the behaviour shown by their trading partners. In the positive and neutral conditions, trustworthiness ratings and sharing decreased, while in the negative condition an increase was found. This shows that in all conditions participants used the feedback they received about their partner during the game to adapt their behaviour, as well as their subjective opinion of the trustworthiness of their partner. However, all participants continued to share most with the 'good' partner and least with the 'bad' partner, despite similar reinforcement rates. Interestingly, due to this higher rate of share decisions in the positive condition, participants received the largest amount of feedback about the 'good' partner's behaviour, as the participant only received feedback about their partner's decision after sharing with their partner. Keep trials, which occurred most when playing with the 'bad' partner, did not lead to feedback as the partner was not able to make a decision if the participant did not allocate them money to make a decision about.

The finding that initial levels of trust influence changes in levels of trust over the course of interactions has been demonstrated in previous studies. A recent study by Chang and colleagues (2010) showed that subjective levels of reported trustworthiness following an iterated trust game were the result of an interaction

between initial levels of trust and the partner's behaviour during the game. Those partners who reciprocated more frequently were rated as more trustworthy than those who reciprocated less frequently. However, there were differences within this group. Within the group of high reciprocators, partners that had initially been rated as untrustworthy were rated as less trustworthy after the trust game than those that had previously been rated as trustworthy. These findings suggest that though initial trustworthiness judgements can be modified by experience, they cannot be erased completely. Research in adults by Delgado and colleagues (2005) has suggested that this is particularly the case when a partner is initially viewed as trustworthy. This leads to decreased sensitivity to feedback following positive information about an interaction partner, as a result of reduced activation of the caudate nucleus, the area in the brain involved in reinforcement learning. Therefore, trials in which the 'good' partner violates expectations by choosing not to reciprocate, do not lead to encoding of this evidence and subsequent learning to the same degree as in the neutral and negative conditions. This idea is strengthened by other research showing that participants continue to show increased trust in a partner who previously included them in an online game, despite this partner reciprocating in a similar manner to a partner who excluded them during the game (Hillebrandt, et al., 2011). Research by Averbeck and Duchaine (2009) has shown a similar bias towards positive information. They found that participants overweighed positive outcomes accompanied by a happy face and underweighted positive outcomes associated with sad or angry faces when making successive decisions. It seems that positive social information creates a strong prior belief which influences subsequent decision-making behaviour.

Interestingly, the aforementioned finding that adolescents show decreased sensitivity to feedback following positive social information was found to change with age. When playing with the positive partner, the older age groups showed a larger decrease in trust over the course of the task than the youngest age group. In the negative and neutral conditions, trustworthiness and sharing changed similarly across age groups. We initially expected the influence of feedback to increase with age in all conditions, in line with the increased integration of cognitive and emotional networks in the brain (Steinberg, 2008). Greater integration of these networks would

allow better regulation of behaviour and decrease the salience of the information participants received prior to the task. However, age effects were only observed in the positive condition. As has previously been discussed, research in both adolescents and adults has found persistent strong effects of a bias towards positive information (Averbeck & Duchaine, 2009; Hillebrandt, et al., 2011). It is possible that greater integration of cognitive and emotional networks may be needed to overcome the bias created by positive information than the bias created by neutral and negative information. This is also suggested by recent work by Somerville, Hare and Casey (2011) who showed that during adolescence the cognitive control system is unable to overrule the strong approach motivation resulting from positive stimuli such as happy faces. In contrast, this effect was not found for neutral stimuli (i.e. calm faces). Applied to the current study this means that as integration increases, adolescents become gradually more able to incorporate feedback about the behaviour of the 'good' partner. Therefore, the change in trustworthiness ratings and sharing with the 'good' partner increases with age. However, as previous studies have shown (Delgado, et al., 2005), even in adults the use of feedback to adjust behaviour in social contexts still poses difficulties, meaning that the strong bias created by positive information continues to be influential in late adolescence and into adulthood.

Limitations of the current study must be noted. Firstly, participants were aware that they were playing against hypothetical partners. Previous research has shown stronger reactions when participants played against a human compared to a computer. For example Van 't Wout and colleagues (2006) demonstrated a greater rejection of unfair offers during an interactive game when the offer was made by a human compared to a computer. The effects found in this study may therefore have been stronger if participants had believed their interaction partners were real. Secondly, all participants in this study played the trust game against the same three partners, described as 16 or 17 year old males. As prior research has shown that individuals infer personality traits and social intentions from faces (Frith & Singer, 2008), the three pictures were counterbalanced across the three task versions, thus minimising effects of differences between the faces in trustworthiness. This also meant that not all adolescents played against a partner similar to themselves in age and sex. Matching

all participants to a same sex partner of the same age would have lead to uncontrolled effects due to possible differences between interaction partners in their facial trustworthiness. Nonetheless, as peer relationships are extremely important during adolescence, the differences between interactions with similar peers compared to peers differing in age or sex is an interesting topic for further research. Finally, we did not examine the effects of pubertal maturation on our age-related findings. Previous research has suggested that the enhanced sensitivity to social and emotional stimuli seen in adolescence is influenced by the hormonal effects of puberty during early and mid adolescence (Dahl & Gunnar, 2009; Spear, 2000). Future studies containing measures of pubertal maturation could therefore give a more extensive explanation of the biological basis of the development of trust behaviour.

In summary, the current study shows that social information about an interaction partner influences trust behaviour and that this influence changes during adolescence. We used a large sample of adolescents consisting of three clearly delineated age groups spanning the adolescent developmental continuum. In contrast to the anonymous interactions studied in previous research, we examined the effects of social information prior to the trust game, as well as the influence of feedback during the trust game. Decision-making in a social context is representative of what adolescents are faced with in daily life. Therefore our results are more applicable to real-life situations than previous work, and fit within recent suggestions that studying social situations is of increasing importance to the field of cognitive neuroscience (Todorov, Harris, & Fiske, 2006).

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